

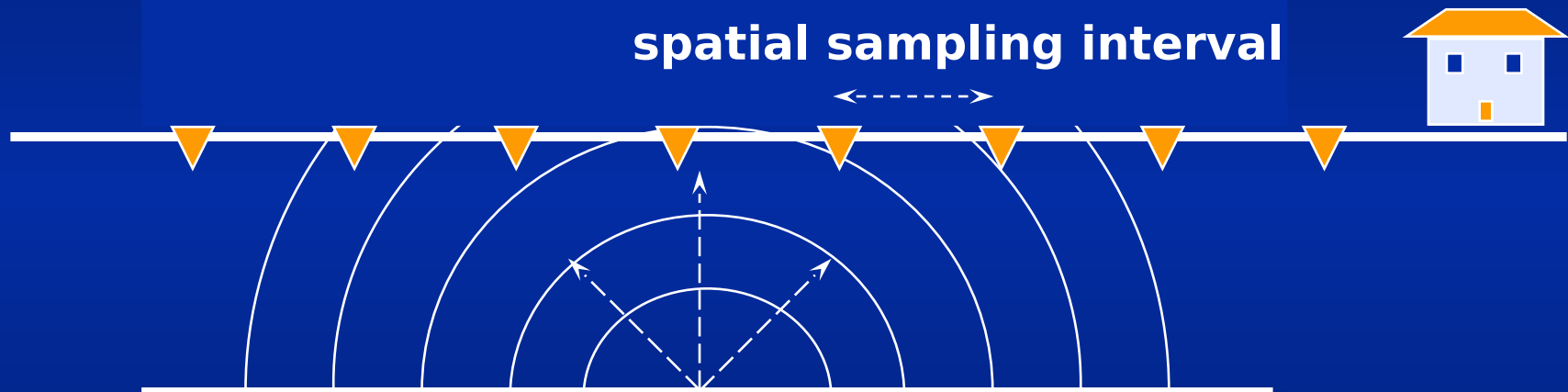
Spatial Sampling

At the end of this Session, you will be able to:

- **Define the term spatial sampling as used in data processing.**
- **Define the term K.**
- **Describe why we apply spatial re-sampling to data during processing.**
- **Describe the effects of spatial re-sampling on data.**
- **Calculate the K Nyquist value for a given spatial sample interval.**
- **Define the term K filter.**
- **Describe 4 different methods of trace reduction.**

Spatial Sampling

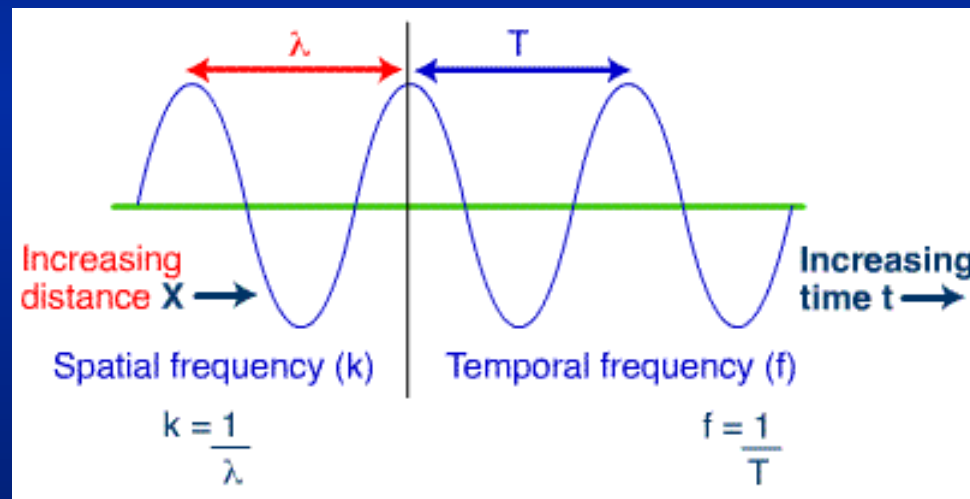
Spatial Sampling is the process of measuring the amplitude of a wave using receivers spaced at known and fixed distances apart.



Reflected seismic signal

Spatial Sampling

Lets look at a waveform in space. We're now interested in the space required for a cycle of the wave ie wavelength



K

But what is K?

It's the number of wave cycles per unit distance

K is the measure of spatial frequencies

just like

Hz is the measure of temporal frequencies

Spatial Re-sampling - Why

Why do we record shot data with a fine spatial sampling interval only to throw half of it away during processing?

Let's take a look at some typical geometry

$$\text{FOLD} = (\text{Groupint}/\text{Shot int}) * (\text{No.channels}/2)$$

$$\text{CMP INT} = (\text{Groupint}/2)$$

sp_int 25metres

flip-flop

num_chans

480

FOLD = 60

grp_int

CMP_INT = 6.25m

sp_int 25metres flip-flop

num_chans 240

grp_int 25m

FOLD = 60

CMP_INT = 12.5m

Now if we drop every second trace

So we still have the same fold just a larger cmp interval

Spatial Re-sampling - Why

The client may choose to retain and process all traces, especially if a fine spatial sampling interval is required (high-resolution surveys). However, for purely economic or speed of processing reasons, the client may choose to discard recorded traces during processing, and accept the fact that the resultant dataset will have a coarser spatial sampling interval.

Spatial Sampling - Nyquist

Remember the K Nyquist where sampling above this value can lead to aliasing

$$KN_q = 1/2 \delta x$$

So for our earlier example with receivers evenly spaced at 12.5m what is the K Nyquist? K is always stated in cycles/km

40 cycles/km

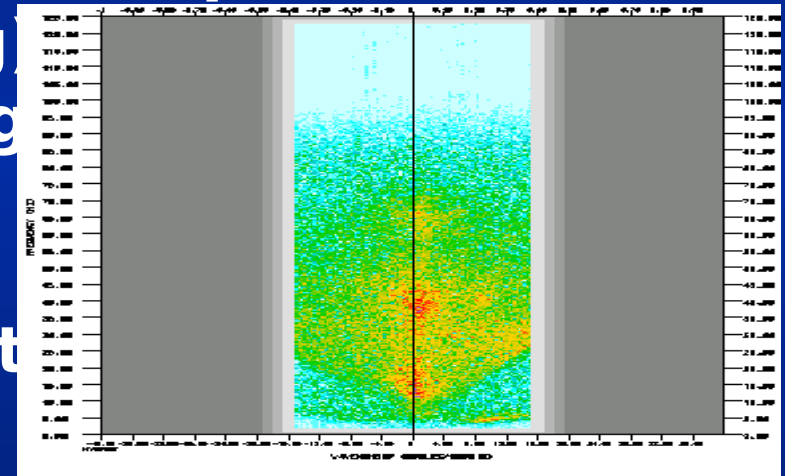
And after resample with receivers evenly spaced at 25m what is the k Nyquist?

20 cycles/km

K Filter

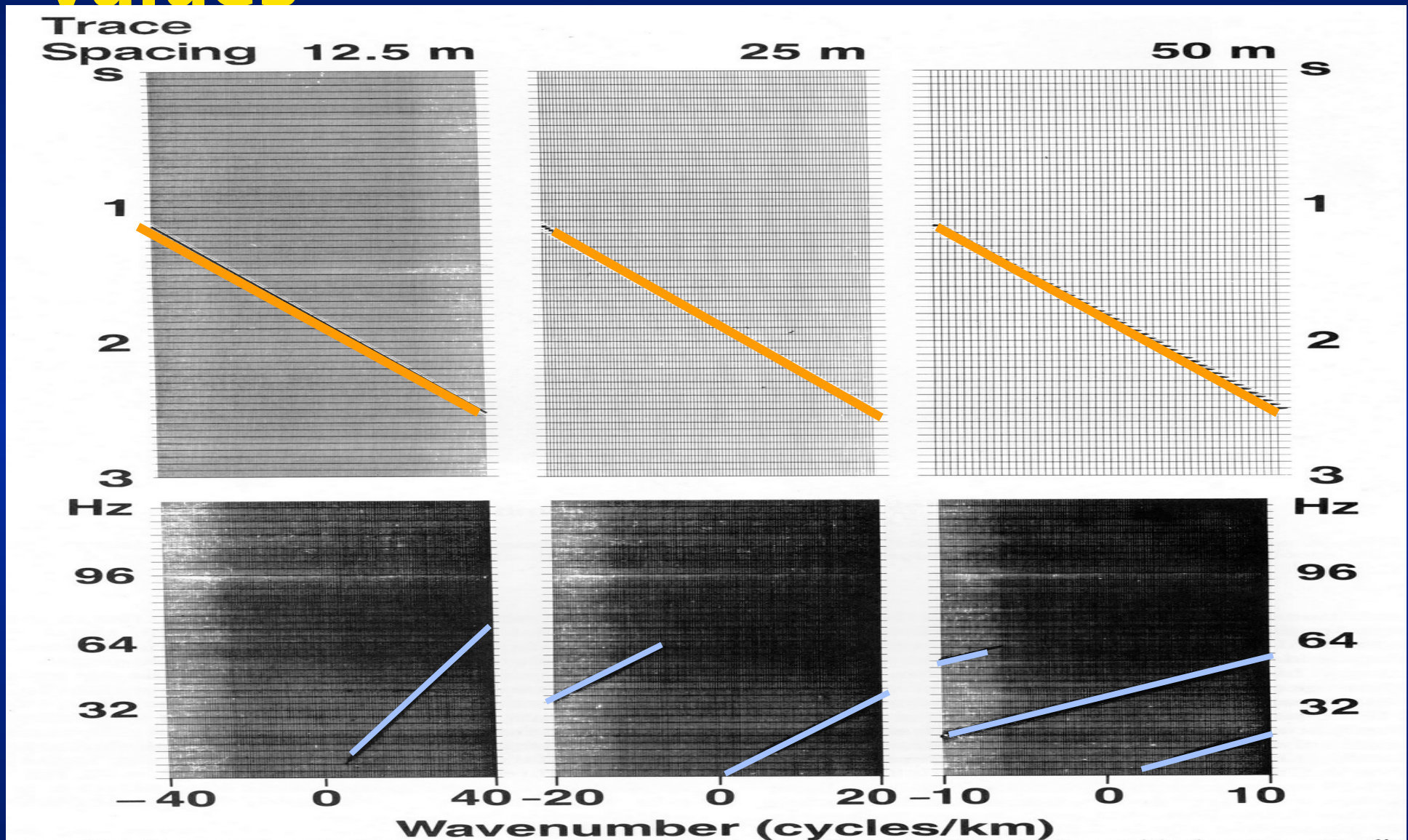
For temporal resample we apply an anti-alias filter to remove any frequencies that will be aliased after resample we do the same for spatial resample . However this time the filter is not specified in frequency (temporal sampling) wavenumber (spatial sampling)

So a K Filter is basically a spatial



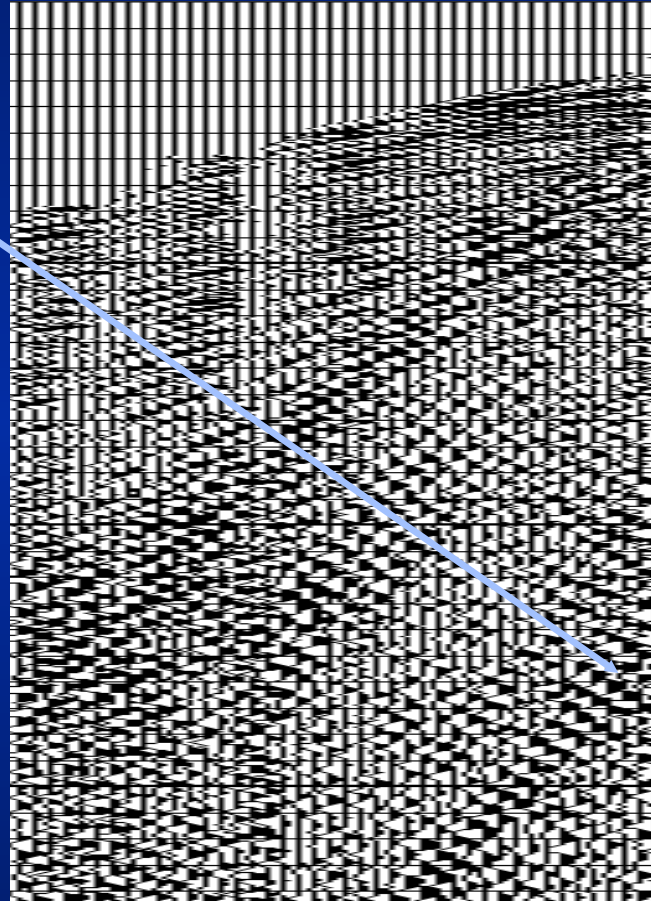
So again looking at our example geometry case. We would apply a K-filter to remove all energy with a K value above 20 cycles/km to avoid aliasing, before we resample (ie trace drop or trace summation).

Spatial sampling and K Nyquist values

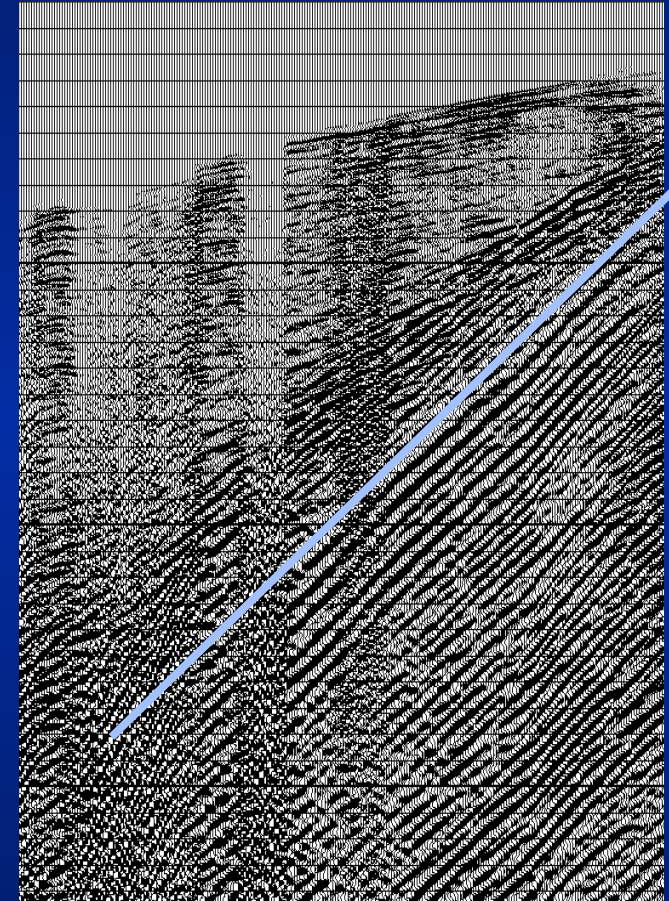


Aliased Noise

On the left data is now aliased. This means the data appears to be dipping in the opposite direction



Big distance between receivers



Small distance between receivers

Methods of trace reduction

1. Simple rejection of traces
2. Trace summation after differential NMO correction
3. Full NMO correction, K filter application, trace drop, Inverse NMO
4. Full NMO correction, trace mix (using pre-defined coefficients), trace drop, Inverse NMO

Simple rejection of traces

This method should be used with caution and client approval, as there is no application of a K-filter. The output data will likely contain aliased noise.

Adjacent trace summation after differential NMO correction

This procedure first applies differential NMO to the prestack shot data, so that adjacent traces have the same offset and have the required differential NMO applied such that they appear to have that same offset. Once that has been achieved, the adjacent traces are summed together.

When using this technique, be sure that you are confident that differential NMO is doing exactly what you want it to do. Remember that this process will physically change the offsets in the trace headers, so care is warranted. Also, the velocity field used for differential NMO does not have to be perfect (unlikely at this stage of processing anyway), but should be a reasonable estimate.

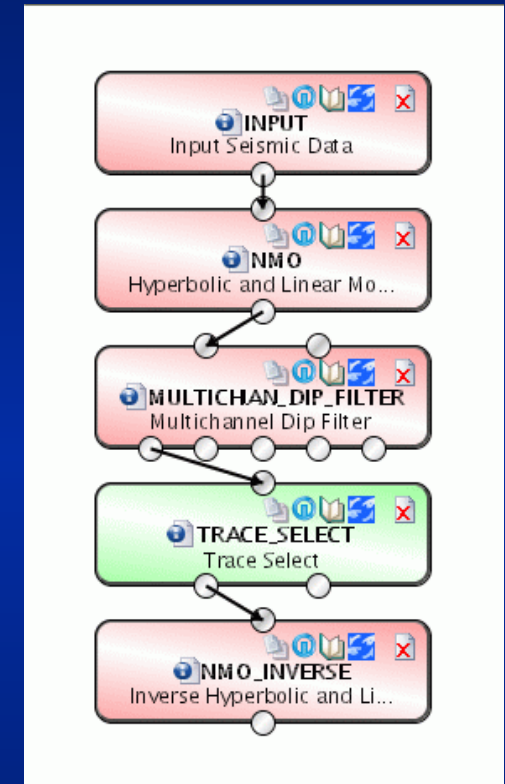
Full NMO correction, K filter application, trace drop, Inverse NMO

Taking our old geometry example if our trace spacing was 12.5m (ie $K=40$) and we trace drop to 25m (ie $K=20$)

Firstly we apply an NMO correction so that all our events are flat and so map around $K=0$.

We then apply a K-filter removing any data which has a K value greater than 20, using the multichan_dip_filter.

We then drop alternate traces using trace_select.



Full NMO correction, trace mix, trace drop, Inverse NMO

Here we are substituting a trace mix (using pre-defined coefficients) for the K filter. This procedure is gradually replacing the application of a K filter using the

